Posterior corneal aberrations and their compensation effects on anterior corneal aberrations in keratoconic eyes

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Introduction

In normal eyes, the posterior corneal aberration has a relatively small impact on optical quality of the eye due to the smaller refractive index difference between cornea and aqueous. However, in keratoconic eyes, contribution of the posterior corneal aberration to the total ocular aberration becomes more significant with an increase in corneal irregularities. Some of the anterior corneal aberration can also be compensated by the posterior corneal aberration. The goal of this study is to characterize posterior corneal aberrations in keratoconic (KC) eyes and to investigate the compensatory effects between anterior and posterior corneal surfaces.

Vector analysis of aberration

### Characterization of posterior corneal aberration

Posterior aberration in KC eyes is significantly larger than in normal eyes.

<table>
<thead>
<tr>
<th>Magnitude of posterior corneal HOA (µm)</th>
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<tbody>
<tr>
<td>15 µm</td>
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<tr>
<td>20 µm</td>
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<tr>
<td>25 µm</td>
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<tr>
<td>30 µm</td>
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<tr>
<td>35 µm</td>
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<tr>
<td>40 µm</td>
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<tr>
<td>45 µm</td>
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</tbody>
</table>

### Mirror symmetry between OD and OS

OD OS

<table>
<thead>
<tr>
<th>Mirror symmetry</th>
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<tbody>
<tr>
<td>75±19 deg</td>
</tr>
<tr>
<td>78±20 deg</td>
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</tbody>
</table>

### Posterior corneal compensation effects

Angle difference ($\Delta\theta$) between anterior and posterior corneal aberration was close to 180 deg (168 deg for coma) indicating the compensation effect between the cornea surfaces.

#### Anterior corneal HOA

- Normal
- Mild
- Moderate
- Advanced

#### Posterior corneal HOA

- Normal
- Mild
- Moderate
- Advanced

In moderate and advanced KC, the total corneal HOA was significantly smaller than anterior corneal HOA due to the posterior corneal compensation effect.

## Conclusions

- The posterior corneal aberration is increased with an increase in corneal irregularities.
- Strong HOA compensation effect (comom:~20%) between anterior and posterior corneal surfaces was found in KC eyes while no compensation was found in the normal eye.
- Uncorrected posterior corneal aberration in KC eyes with a conventional RPG lens can degrade visual performance significantly.

Subjects and Methods

- **Subjects**
  - 31 normal eyes
  - 82 KC eyes: 37 advanced 31 moderate 14 mild
- Corneal aberration was computed from the elevation data obtained with Orbscan IIz (Bausch & Lomb).
- Vector analysis was performed to combine each pair of higher order aberrations ($Z_{n}^w$ & $Z_{n}^a$).
- Similar analysis method was used to quantify the compensation effects between anterior and posterior corneal surfaces.

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